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APPLICATION OF COSMOGRAPHIC PERSPECTIVES IN THE INTERPRETATION OF PHOTOGRAPHS TAKEN IN SPACE

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ABSTRACT. Discussion of the development of a new way of drawing azimuthal perspective projections of the earth, the so-called "cosmographic projections." Their main advantage is that they present the globe as seen from a finite distance and can thus replace orthographic projections which should only be used for the reproduction of heavenly bodies obtained by means of a telescope from quasi-infinity.

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Azimuthal perspective projections presenting the surface of the globe as /59* if seen from a finite distance were described by N. M. Volkov (construction and distortion only), and he called them "External Perspective Projections With a Positive Image of the Surface of the Globe."[1] I was not aware of this work, so I developed new types of perspective azimuthal projections in another way. I call them "cosmographic perspectives."[2] This name, it sees to me, is more appropriate because on these projections it is possible to obtain photography of any cosmic body by automatic planetary stations in space as if seen in accordance with the laws of perspective.

I constructed several grids of cosmographic perspectives with meridians and parallels at 10° intervals, and, as in the case of all azimuthal projections, the verticals are great circles on the globe, and the parallels of altitude are circles with a common center in the pole of the projection (at the center of the grid), converging to a greater degree than is the case in orthographic projections with distance from the center of the projection to the extreme parallel of alti-

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1. Geodeziya i kartografiya, 1964, No. 4.

2. The paper "Cosmographic Perspectives - A New System of Azimuthal Projections," was published in the Rumanian journal "Natura," 1965, No. 6.

* Numbers in the margin indicate pagination in the foreign text.

tude. Their approximation, as well as their distortion, is much more sharply expressed when the point of view is closer to the globe and the visible segment of the globe is smaller. The meridians and parallels are curves obtained by slanted planes intersecting a cone. The following variants of the projections are special cases:

1) polar (Figures 1,2), in which the meridians are straight lines (they coincide with the verticals), and the parallels, coinciding with the parallels of altitude, are shown as circles;

2) equatorial (Figures 3,4), with the central meridian and the equator shown as straight lines;

3) horizontal (oblique), the equator and the other parallels of which are curved lines (Figures 5,6,7,8).

The chief property of the cosmographic perspectives is that they present an image of the globe as seen from finite distances. These projections, therefore, can successfully replace orthographic projections, the use of which is recommended only for images of heavenly bodies obtained by telescope from quasi-infinity.

Today, spacecraft and automatic stations already have begun to explore the moon and the closest of the planets, and to send photographs back to the earth. A new science has been born, very aptly called cosmic photography, which, as distinguished from aerial photography, which is concerned with surfaces as seen from short distances, should take into account the shape of the planet. The task of cosmic photography is that of compiling accurate charts of the heavenly bodies.

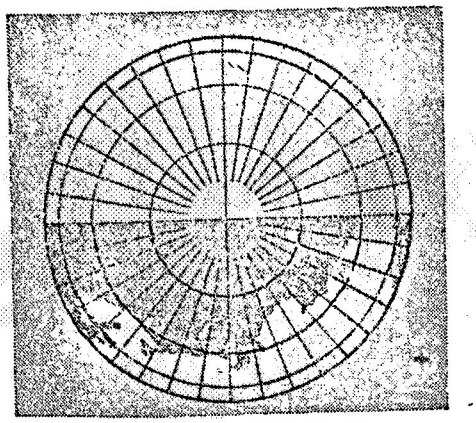

Figure 1

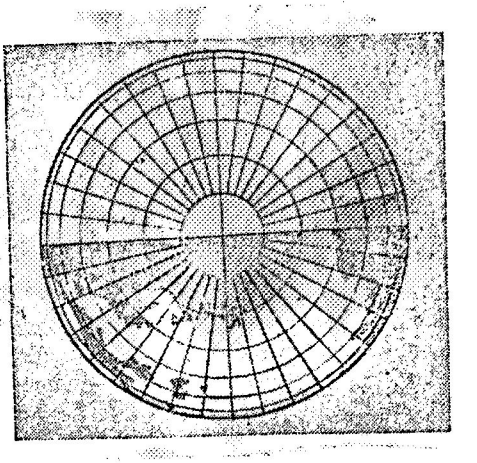

Figure 2

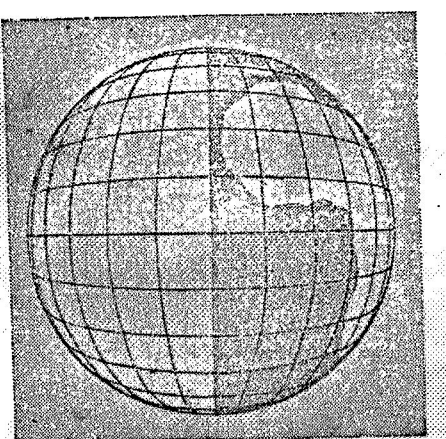

Figure 3

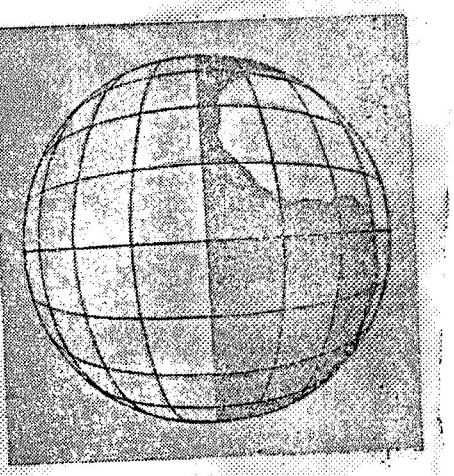

Figure 4

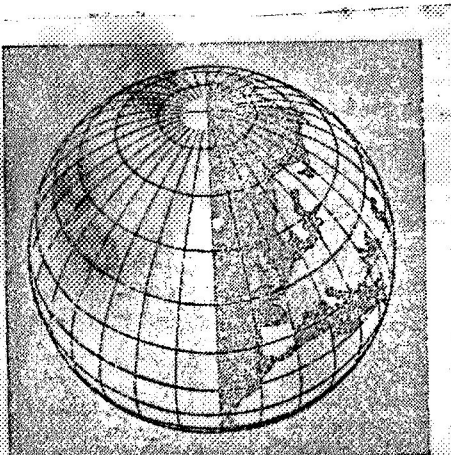

Figure 5

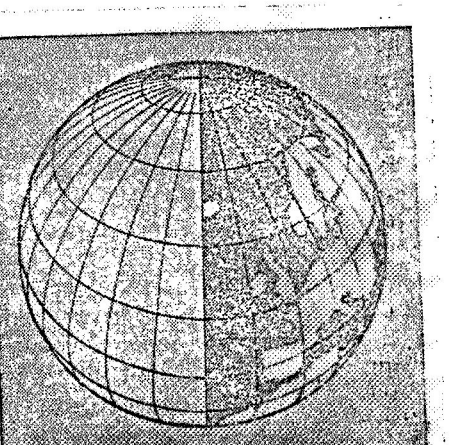

Figure 6

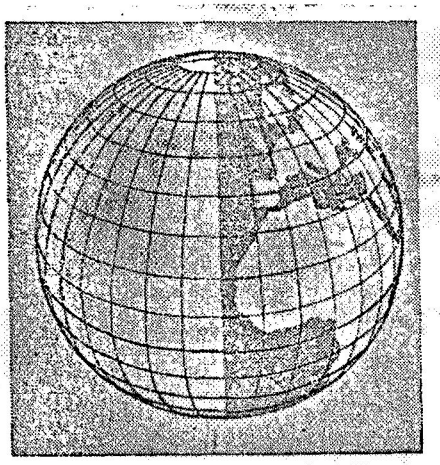

Figure 7

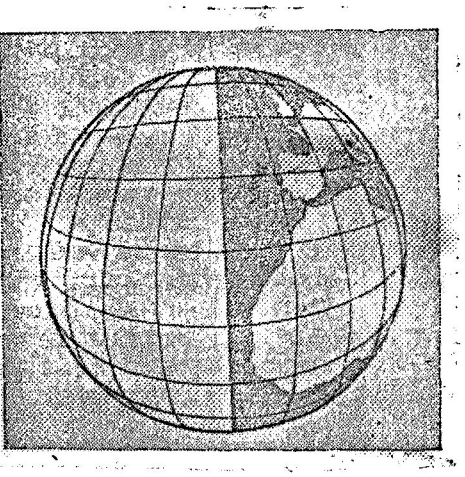

Figure 8

Cosmographic perspectives can be of great practical importance in space research by simplyifying the joining of space photography and its interpretation. All that need be known for this purpose is some of the data, including the distance from which the photographs of the planet were taken, and the point over which the station was located at the time the photographs were taken. By overlaying a photograph, which has no meridians and parallels, with /61 the calculated cosmographic grid, we can obtain the coordinates of any points (cirques, craters, mountains, valleys, canals, favorable launch areas, and the like). It is quite simple to join a series of photographs to which meridians and parallels have been applied. Photographs and maps constructed on a cosmographic perspective base also can be transformed into any other cartographic projection if it is necessary to distinguish special features, or to make comparisons, or accurate measurements (of areas, distances, angles, determination of a great circle or a rhumb line, etc.).

Later on it will be possible to study even more complicated cases, such as those, for example, when the axis of the line of sight of the camera does not coincide with the vertical of the place, or when the planet being studied has greater ellipticity. Rectifiers also can be used in the first of these cases. It is more advantageous, of course, to take pictures with equipment aimed at the center of the planet and in this way obtain a negative, the center of which will show the least distorted sections. Other possible cases include the construction

of grids, with more frequent meridians and parallels showing the limits of sections of surfaces and for photographs of large sections of the earth's surface obtained when the spacecraft was close to the planet but the camera lens was unable to take it all in. Grid construction in this case requires a knowledge of the coordinates of several landmarks (two at the very least), and these can have been obtained from other images.

Cosmographic perspectives also can be used quite widely to investigate and observe our planet. There is no need to compile maps on a cosmophotogrammetric basis for this purpose because we have extremely detailed maps made on a geoletic base. At this point one can pose the question of providing more precision for some of the general details. However, the exposure and observation of certain of the phenomena, fixed, or moving, on the surface of the globe, and which are observable, or which could be made observable, on space photographs, taken over known time intervals, is of interest. So it will be possible, for example, to observe the distribution and movement of cloud masses, the origination, direction, and speed of movement of tropical cyclones, distribution of snow, /62 polar ice, iceberg zones, stages of development of vegetation at different times of the year, shifts in ocean currents, and the like.

It is quite difficult to pinpoint the geographic positions of these phenomena on unprocessed space photographs (without grids), particularly on the high seas, where there are no natural landmarks (shorelines, islands). Localization on space photographs with plotted grids reduces to reading coordinates, and the closer spaced the grid, the easier and more accurate is the localization. Moreover, localization of cloud masses over continents will be more certain if, in addition to the meridians and parallels, the space photographs have plotted on them shorelines, rivers, cities, mountains, and the like. In other words, compile a map of the locality that will include for purposes of orientation as many landmarks as possible, the limits of display of which will depend on the possibilities provided by the scale of the photography. Then we will be able to recognize countries, or regions (from large to small) covered by clouds. They are not visible on unprocessed space photography. Images "restored" in this manner can also be used to refine those parts of images which, because of atmospheric pollution, show up fuzzy on space photography.

Of course, when, in the course of mastering space for peaceful purposes, rocket probes and satellites will begin to function on a regular basis, the interpretation of space photography will become extremely current, and cosmographic perspectives will be used more and more extensively.

The era of space navigation, on which man already is embarked, has opened up new vistas for all sciences, and they in turn, are contributing to our knowledge of space. Cartography will expand the sphere in which it is working, a sphere that has been limited up to this point to our planet, and to its satellites, the moon, and the other bodies in space.

The universe, with its infinite distances in space and time, presents the cartographer with interesting problems concerning the images of the surfaces of the various planets, the dynamics of planets and the phenomena they spawn, orientation in space and time, images of space paths, "space block diagrams," for example, problems of space stereophotography, and the like. In the future, and the not too distant future at that, perhaps, we will be using "cosmographic atlases" along with geographic atlases. Just as the development of geography stimulated development in the field of cartography, so too will the era of space navigation expand its field of application.

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